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10/679,031

10/03/2003

Satoshi Komiya

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EXAMINER

SONG, MATTHEW J

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PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

| | | | |
|------------------------------|--------------------------------------|--------------------------------------|--|
| Office Action Summary | Application No. 10/679,031 | Applicant(s) KOMIYA ET AL. | |
| | Examiner MATTHEW J. SONG | Art Unit 1792 | |

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 01 November 2007.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 44 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 44 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____ |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application |
| Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Withdrawn Rejections

1. Applicant's arguments, see page 5 of the remarks, filed 11/1/2007 with respect to the rejection(s) of claim(s) 44 under 35 U.S.C 103 have been fully considered and are persuasive. Therefore, the rejection has been withdrawn. However, upon further consideration, a new ground(s) of rejection is made in view of Sakata et al (US 5,705,423).

Claim Rejections - 35 USC § 112

2. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

3. Claim 44 is rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. Claim 44 recites, "mirror polishing the obtained silicon wafer substrate and then immediately after the step of mirror polishing, subjecting the obtained silicon wafer substrate to epitaxial growth processing" in the last three lines. There is no support for "immediately." Page 7 of the specification merely teaches epitaxial growth was performed thereon after processing by mirror polishing.

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4. Claim 44 is rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the enablement requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention. Claim 44 recites, “mirror polishing the obtained silicon wafer substrate and then immediately after the step of mirror polishing, subjecting the obtained silicon wafer substrate to epitaxial growth processing” in the last three lines. The specification does not enable one of ordinary skill in the art to make the invention because “immediately” would suggest that epitaxial deposition occurs after the polishing process without washing or drying the substrate to remove the polishing compound and material from the surface prior to epitaxial growth. Therefore, the ability to produce an epitaxial layer on a substrate which is not cleaned is not enabled because the debris and polishing compound would provide a surface which is not capable of epitaxial growth.

5. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

6. Claim 44 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Claim 44 recites, “mirror polishing the obtained silicon wafer substrate and then immediately after the step of mirror polishing, subjecting the obtained silicon wafer substrate to epitaxial growth processing” in the last three lines. It is unclear what “immediately” is intended to limit. There is no guidance in the original disclosure for “immediately.” It is unclear if

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"immediately" is intended to exclude the step of transferring the wafer from the polishing chamber to an epitaxial deposition chamber, or if "immediately" is intended to excluding washing and drying the wafer after polishing. For the purpose of expediting examination, the limitation is interpreted to mean that other steps can occur, and that washing and drying are part of the mirror polishing step.

7. Claim 44 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Claim 44 recites, "oxygen concentration and nitrogen concentration are plotted along the horizontal and vertical axis" in lines 7-8. It is unclear whether oxygen is plotted on the horizontal or vertical axis, and it is unclear whether nitrogen is plotted on the horizontal or vertical axis. The Examiner suggests using "the oxygen concentration plotted on _ axis and nitrogen plotted on the _ axis", such that it is clear which concentration is plotted on what axis.

8. Claim 44 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Claim 44 recites, "setting a lower limit of the amount of added nitrogen, which is a function of an initial oxygen concentration of a silicon wafer substrate for ensuring a sufficient density of oxygen precipitates as gettering sites" in lines 8-10. First, is unclear what is a "sufficient density of oxygen precipitates as gettering sites". In other words, if 1×10^5 or 1×10^{10} sites/cm³ would be sufficient a sufficient density. Second, it is unclear how to set the lower limit. The claim merely recites, "nitrogen, which is a function of an initial oxygen concentration" but

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there is clear definition of the lower limit of nitrogen and oxygen concentration. In other words, the upper limit is defined as a particular nitrogen and oxygen concentration, however the lower limit is merely defined used indefinite language, such that it is unclear whether a particular nitrogen and oxygen concentration would be above the lower limit.

Claim Rejections - 35 USC § 103

9. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

10. Claim 44 is rejected under 35 U.S.C. 103(a) as being unpatentable over Graef et al (US 5,935,320) in view of Ziem et al (US 4,591,409), Tamatsuka et al (US 6,162,708), and Sakata et al (US 5,705,423).

Graef et al teaches a method of making a silicon wafer comprising pulling a silicon ingot which is doped with nitrogen having a concentration of at least 1×10^{14} atoms/cm³ and oxygen having a concentration of at least 4×10^{17} atoms/cm³ (col 3, ln 10-50). Graef et al also teaches a particular embodiment where a wafer is produced from a Czocharlski process wherein the single crystal has a nitrogen concentration of 3×10^{14} atoms/cm³ and an oxygen concentration of 9×10^{17} atoms/cm³ (col 5, ln 45-60), this meets applicant's claimed range because it falls below applicant's claimed upper limit. Graef et al also teaches slicing the single crystal to form wafers (col 4, ln 1-15).

Graef et al teaches pulling a single crystal with a a nitrogen concentration of 3×10^{14} atoms/cm³ and an oxygen concentration of 9×10^{17} atoms/cm³, however Graef et al does not teach controlling an oxygen concentration in accordance with a change in a nitrogen concentration based on a characteristic that nitrogen concentration increases from a shoulder to a tail portion of a silicon ingot and the nitrogen concentration at the tail portion is less than 3×10^{15} a nitrogen concentration of 3×10^{14} atoms/cm³ and an oxygen concentration of 9×10^{17} atoms/cm³.

In a method of controlling nitrogen and oxygen in silicon during crystal growth, note entire reference, Ziem et al teaches producing a single crystal silicon from a silicon melt wherein dopants such as oxygen and nitrogen are uniformly distributed in the crystal along the crystal axis (col 1, ln 60-68). Ziem et al also teaches the concentration of the dopant in the crystal during the single crystal growth process is a direct function of the dopant concentration in the melt and the segregation coefficient of that impurity (col 1, ln 10-60). Ziem et al also teaches the segregation coefficient of oxygen causes the oxygen concentration to be high at the top of the crystal and low at the bottom, and the reverse being true for nitrogen, which clearly suggests that the nitrogen

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concentration naturally increases from the shoulder (top of the crystal) to a tail portion (at the bottom of the crystal). Ziem et al teaches controlling oxygen and nitrogen by controlling a nitrous oxide partial pressure above the melt (col 5, ln 1-15).

It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Graef et al by using Ziem et al's method of controlling nitrogen and oxygen concentration in a silicon crystal to be uniform along the axis of the crystal during growth to form a crystal with uniform characteristics from the shoulder to the tail portion of the crystal ('409 col 1, ln 60-68), such that the entire crystal has the desired nitrogen concentration of 3×10^{14} atoms/cm³ and oxygen concentration of 9×10^{17} atoms/cm³ ('320 col 5, ln 45-60).

The combination of Graef et al and Ziem et al does not teach subjecting the obtained silicon wafer to an epitaxial growth processing.

In a method of producing an epitaxial silicon single crystal wafer, note entire reference, Tamatsuka et al teaches forming an epitaxial layer in the surface layer portion of silicon single crystal wafer silicon from a silicon ingot formed from a Czochralski method (Abstract). Tamatsuka et al also teaches epitaxial silicon wafers have been used as wafers for producing discrete semiconductor and bipolar IC (col 1, ln 10-30).

It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Graef et al and Ziem et al by subjecting the silicon wafer to epitaxial process to produce an epitaxial wafer which is useful for producing semiconductor devices, as taught by Tamatsuka et al.

The combination of Graef et al, Ziem et al and Tamatsuka et al does not teach epitaxial growth immediately after mirror polishing.

In a method of making an epitaxial wafer, note entire reference, Sakata et al teaches mirror polishing a silicon wafer cut from a silicon single crystal rod and performing epitaxial deposition on the mirror polished wafer (col 4, ln 1-67), this clearly suggests epitaxial deposition immediately after polishing. Sakata et al also teaches the surface condition of a wafer directly influences the properties of an epitaxial layer formed thereon. (col 4, ln 15-30).

It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Graef et al, Ziem et al and Tamatsuka et al by forming an epitaxial layer on a mirror polished substrate, as taught by Sakata et al, to produce a useful epitaxial wafer on a substrate with suitable surface roughness.

Response to Arguments

11. Applicant's arguments with respect to claim 44 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

12. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37

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CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

13. Any inquiry concerning this communication or earlier communications from the examiner should be directed to MATTHEW J. SONG whose telephone number is (571)272-1468. The examiner can normally be reached on M-F 9:00-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Michael Barr can be reached on 571-272-1414. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Matthew J Song
Examiner
Art Unit 1792

MJS
February 12, 2008

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/Robert M Kunemund/

Primary Examiner, Art Unit 1792